# Chapter 8
# Water and Waste Management Technologies

Apart from energy, the usage of water and management of waste are important aspects of green buildings. Buildings use significant amount of water for various needs such as sanitation, kitchen, laundry, utilities, heating/cooling and landscaping needs. The availability of clean water is a major challenge in several parts of the world and hence water conservation in buildings is imperative. Also buildings can lead to significant waste generation throughout its lifetime, right from its construction phase to its demolition. The waste generated by the building occupants and facilities also needs to be managed in order to reduce its environmental impacts.

## 8.1 Water Consumption, Monitoring and Leak Detection

In buildings, water is typically consumed for the following purposes:

- Sanitation: toilets, showers and was basins
- Washing: laundry, cleaning of floors and other building surfaces
- Kitchen: food preparation, washing and drinking water
- Equipment: Heating, ventilation and cooling systems use water
- Landscaping: for maintaining greenery, gardens and plants in the building.

Typically water is imported into the building from the water utility provisions and then stored and transported to various places in the building through pipes and pumping system. There could be however different grades of water used for the different purposes that are described above and it's important to specify and understand the different water types and then devise the appropriate conservation measures.



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## *8.1.1 Identifying the Different Water Types in Buildings*

### 8.1.1.1 Potable Water

Potable water is water which fit for consumption by humans and other animals. It is also called drinking water, in a reference to its intended use. In many first world and developed countries the fresh water piped into buildings is potable water. In many other countries the water supplied by the utility to the building has to be further treated and purified to be fit for human consumption.

### 8.1.1.2 Black Water

The term ‘black water’ is used to describe wastewater containing contaminants such as human faeces, urine etc. from toilet flushing and cleaning. It often end up in sewage for discharging out of the building almost immediately after use as it can pose health hazard for the occupants of the building.

### 8.1.1.3 Greywater

Greywater refers to untreated wastewater that has not come into contact with sewage. It can be the wastewater generated from household uses like bathing and washing clothes, foods and dishware but not from toilets. In many utility systems around the world, greywater is combined with black water in a single domestic wastewater stream. Greywater can be of far higher quality than black water because of its low level of contamination and greater potential for reuse (Allen et al. 2010).

### 8.1.1.4 Process Water

The term ‘process water’ is used typically used in relation to industrial plants, industrial processes, production facilities and laboratories. However in commercial buildings, the process of heating, ventilation and cooling also uses water and this can be classified as process water in buildings. The water used for air heating and cooling is often circulated in a closed loop and its temperature differential is used for air cooling. In case of heating this is referred to as the hot water or steam circulation and in case of cooling it is often referred to as chilled water circulation. In cooling towers, water is used for evaporative cooling and it is lot with the air as humidity. In a reverse way, when air is dehumidified, there is water generated from the air known as condensate water. Condensate water is essentially distilled water, low in mineral content, but may contain bacteria from the air.

### 8.1.2 Water Sub-metering and Leak Detection

Typically, the amount of water supplied to the building by the utility provider is based on a utility meter and its used to charge the building for its water usage. However, it's also important to understand the water usage within the building and its various provisions and this is where sub-metering helps. Sub-metering can provide important information to analyse water usage in a building and also provide insights into ways to reduce the wastage of water through benchmarking and other calculations such as water balances.

Leaks in water transport system (pipes, pumping and storage tanks) can be major cause of water wastage and loss in buildings as the undetected leak can keep on siphoning useful water (such as potable and process water) into sewage system. Numerous factors can cause leaks in buildings such as old or poorly constructed pipelines, inadequate corrosion protection in the piping system, poorly maintained valves, poor sealing and mechanical damage. In commercial and institutional buildings, water supplied by the main is often stored in tanks prior to its use. The structural stability of storage tanks can deteriorate over time due to various reasons leading to leaks. Leaks and water loss can also result from malfunction of equipment and instruments such as overflow control valves, shut-off valves, bypass valves and nozzles. A common causes of water leakage in many places are also the dripping taps, faucets and shower heads.

By conducting regular checks for leaks and routine maintenance of equipment, considerable amounts of water can potentially be saved in buildings. A water balance calculation and monitoring of water level in tanks are often simple ways to identify leaks. In commercial and institutional buildings, more complex measures such as continuous monitoring, overnight monitoring, and dynamic water balances may need to be used to determine the extent of leakage.

Not all leaks are however visible and hence can go undetected for a long time and can lead to major water losses. There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground. In addition, correlator devices can listen at two points simultaneously to pinpoint the exact location of a leak (EPD 2007).

## 8.2 Water Efficient Fittings

The best way to directly reduce water consumption in buildings is by using water efficient fittings that can results in immediate and measurable water savings.

### 8.2.1 Water Efficient Faucets and Tap Adaptors

Aerators are devices that mix water and air and can reduce both water flow rates and splashing while increasing areas of coverage and wetting efficiency. Modern faucets come with integrated aerators and aerators as tap adaptors are also separately available that can be integrated with existing taps. Such systems can restrict water flow and result in significant water savings of 40–80 % (DrainWorks 2014). Figure 8.1 show a photo of commercially available aerator fixture for water faucets.

### 8.2.2 Water Efficient Shower Heads

Similar to faucet aerators, efficient shower heads operate by mixing water flow with an air jet. These units provide satisfactory contact with water and achieve effective rinsing with much less water. These can cut water usage by 25–60 % (Drain Works 2014).

### 8.2.3 High Pressure or Trigger Spray Nozzles

High pressure spray nozzles for cleaning of floors as well as dishes and utensils in kitchens can result in significant water savings. Such systems use the jet force of water for cleaning instead of relying on too much water to wash off the contaminants such as dirt and food particles stuck on utensils.

**Fig. 8.1** Photo showing an aerator fixture at a water faucet (DrainWorks 2014)

### 8.2.4 Automatic Water Shut-off Showers and Faucets

Showers and faucets with shut-off systems automatically cut the water flow once a predetermined amount of water has been used. Such systems require user input such as pressing the knob to re-activate the water flow. This can significantly reduce the water usage by avoiding wastage when the user forgets to turn the tap off after use. Hence in common toilets and bathrooms such as in sport facilities, schools, offices and dormitories, such system can save a lot of water without relying user initiative to only use as much water as required.

### 8.2.5 Water On-Demand Sensors

With the use of infrared or motion sensors that can detect a hand under a tap for example, the water flow can be regulated significantly. Such sensors are coupled with water cut-off or cut-in controllers that regulate water flow based on demand rather than human action such as turning a tap valve or pressing a knob to activate water flow. It is essential that such units have a quick response time in order to avoid user dissatisfaction. Figure 8.2 shows a photo of a bathroom with sensor controlled water taps.

**Fig. 8.2** Photo showing a sensor controlled water tap

### 8.2.6 Instant Water Heaters

Instant water heaters help reduce water consumption by avoiding the wait for hot water, which typically causes a lot of cold water to go down the drain. With the use of easily adjustable water mixers with temperature indicators, desired water temperatures can be more easily achieved, thereby wasting less water.

### 8.2.7 Low Volume and Dual-Flush Cisterns for Toilets

The low volume and dual-flush toilets allow for the use of a reasonably low amount of water to flush compared to the old full-flushed toilets. In dual flush cisterns, two options are available for flushing the toilet bowl and the user can use the low volume flush option to save water by using significantly less volume of water for flushing. This choice is typically based on user need e.g. the low flush option can be used after urinating and the high volume flush can be saved for flushing faeces after defecation. Over a long period of time, such systems can result in significant water savings in buildings.

However, these dual flush systems usually require the replacement of not only the cistern and the flushing mechanism, but also the toilet bowl. Therefore, they should be considered when replacing old models or installing new toilets. A simple option to reduce the flush volume in older toilets is to is to place a displacement object inside the toilet cistern. These objects sit inside the cistern tank permanently occupying a reasonable volume without interfering with the operational mechanism of the flush system. Another possible way is to use the so-called toilet dams, which are barriers placed inside the cistern, creating dry compartments and thereby reducing the amount of water used in each flush.

### 8.2.8 Water-Less Urinals

Waterless urinals otherwise known as flush-less urinals came into existence in the bid to create an efficient water usage. Klaus Reichardt, a German, invented the waterless urinals, which have a device installed in it with a sealant liquid such as oil that allow urine to enter the waste water system through one-way or liquid sealed valves. Liquid sealed valves allow urine to seep through the oil blocking the outlet, making use of the difference in densities between the two fluids. Figure 8.3 illustrates the mechanism of water-less urinals.

It is estimated that more than 160 billion gallons of water are flushed down the drains each year due to urinal usage (ZME Science 2013). The use of waterless urinals can hence significantly result in water conservation in buildings. It's

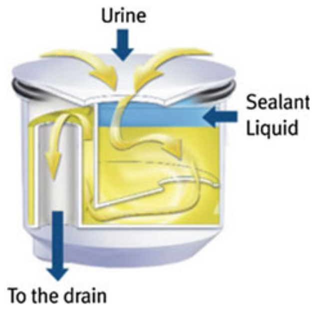


**Fig. 8.3** Mechanism of a water-less urinal (ZME Science 2013)

important however to choose the right waterless urinal and clean it on a regular basis (most urinals can be cleaned simply by wiping the bowl with an all-purpose cleaner) to ensure that odour and hygiene issues are controlled well.

### *8.2.9 Composting Toilets*

A composting toilet uses a predominantly aerobic processing system to treat human excreta, by composting or managed aerobic decomposition. The human excreta is usually mixed with sawdust, coconut coir or peat moss to facilitate aerobic processing, liquid absorption, and odour mitigation. Composting toilets produce a compost that may be used for horticultural or agricultural soil enrichment if the local regulations allow this. The composting chamber can be constructed above or below ground level. It can be inside a structure or include a separate superstructure. These toilets generally use little to no water and may be used as an alternative to flush toilets. Figure 8.4 illustrates the concept of a typical composting toilet.

### *8.2.10 Water Efficient Equipment Labels*

The Environmental Protection Agency (EPA) in the United States of America (USA) has a programme called EPA WaterSense that classifies and labels water efficient equipment and products. The consumers can thus choose more water efficient equipment by simply looking at the WaterSense logo on the products such as showerheads, toilets, bathroom sink faucets, urinals, etc. Products and services that have earned the WaterSense label have been certified to be at least 20 % more efficient without sacrificing performance (EPA 2016).

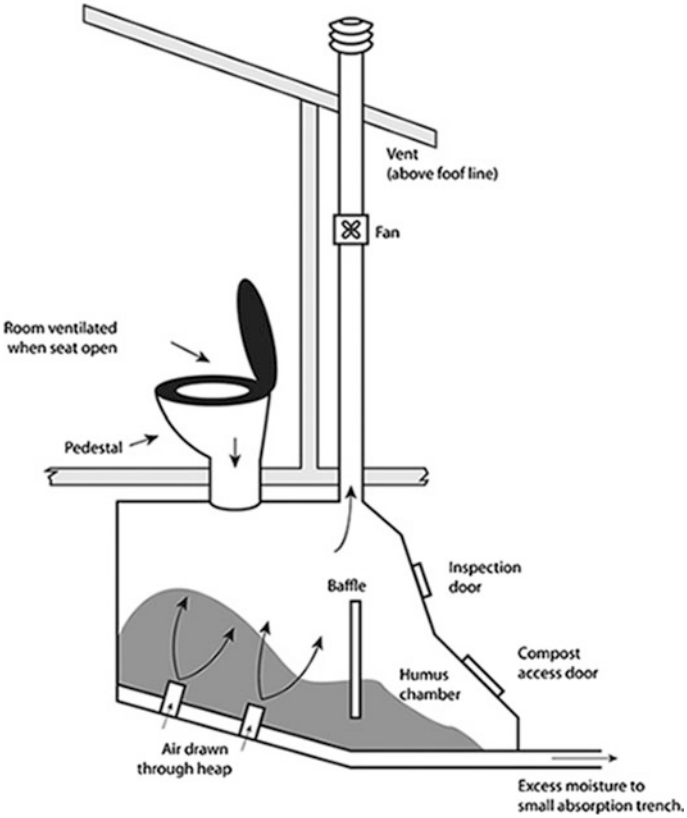


**Fig. 8.4** Diagram illustrating a typical composting toilet (*Source* WaterNSW)

## 8.3 Greywater Recycling

Earlier we discussed greywater as any domestic, household or office-building wastewater without toilet water contamination i.e. different from black water from toilet flushing that is send to sewage immediately. Recycling of greywater has become a matter of importance to the survival of freshwater as the supply of the available freshwater cannot meet the demand of its users.

Most greywater is easier to treat and recycle than black water, because of lower levels of contaminants. If collected using a separate plumbing system from black water, domestic greywater can be recycled directly within the home, garden or company and used either immediately or processed and stored. If stored, it must be used within a very short time or it will begin to decompose due to the organic solids in the water. Recycled greywater of this kind is never safe to drink, but some treatment steps can be used to provide water for washing, gardening, irrigation or flushing toilets.

There are three major ways of treating or recycling greywater namely:

1. Diversion system: Before immediate re-use, this system may filter and disinfect but it doesn't allow for storage. The reuse of greywater for toilet flushing and garden irrigation has an estimated potential to reduce domestic water consumption by up to 50 % (Maimon et al. 2010). Some smart designs integrate the hand-wash sink with the flush water tank of the toilet to enable direct re-use of greywater (see Fig. 8.5).
2. Physical and chemical greywater treatment: This system allows filtered, disinfected and treated greywater to be stored for future use. The treatment destroys the bacteria and other microorganisms that can grow in numbers in immoveable water. Chlorine, ozone or ultraviolet light are all available and efficient disinfection methods. Meanwhile, the disadvantage is that Chlorine and ozone have the tendency to produce toxic by-products, ozone and ultraviolet can be vastly affected by various organic elements in greywater.
3. Biological greywater treatment system: This system uses natural water processing technologies most especially aeration and membrane bioreactors. Through the aeration biological treatment, air is bubbled to move oxygen from the air into the greywater. However, the bacteria in it takes in the dissolved oxygen in the process they digest the contaminated organics thereby decreasing the concentration of pathogens. Moreover, this method can handle varieties of greywater regarding their qualities and quantities which allow for indefinite storage of the recycled water. This system requires high operating cost.

**Fig. 8.5** Toilet that re-uses the greywater from the sink directly above it (Caroma 2016)

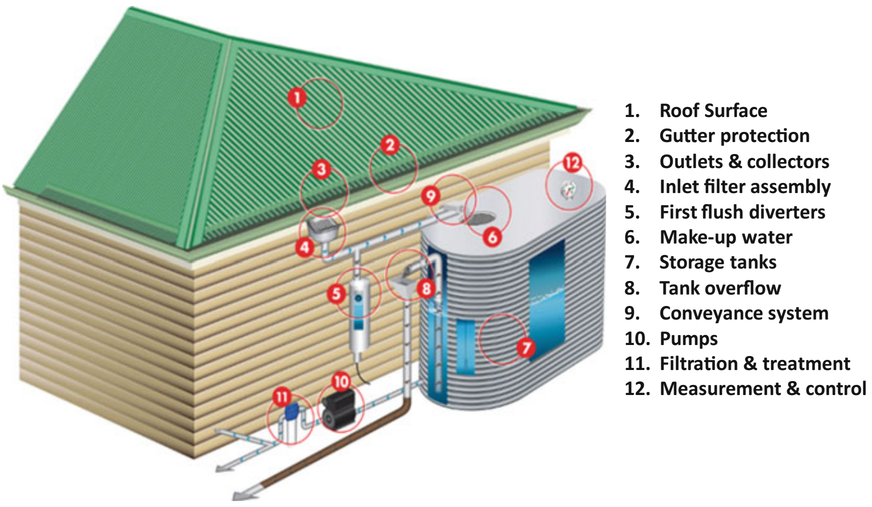


**Fig. 8.6** Components of a rainwater harvesting system in buildings (Rainwater Harvesting Supply Company 2016)

## 8.4 Rainwater Harvesting

Rainwater harvesting is a technique used for collecting, storing and using rainwater. The rainwater is collected from various surfaces such as rooftops and other man-made aboveground hard surfaces. It is then stored and treated for eventual use in the building. Harvested rainwater can be used for varieties of purposes such as watering of the garden, irrigation, household use with deep treatment, and livestock, etc. It is drinkable and it retains its pureness even after the long term of storage. Groundwater recharge can be carried out through harvested rainwater as well. Figure 8.6 shows the components of a rainwater harvesting system in buildings.

## 8.5 Water Efficient Landscaping

Green buildings have greenery incorporated in buildings and the plants and vegetation used in landscaping can consume significant amount of water. There is significant potential for reducing water used for landscaping by choosing the right plant species and irrigation techniques.

### *8.5.1 Drip Irrigation*

Drip irrigation is an irrigation system that supplies waters directly and slowly to the roots or onto the soil surface of numerous plants in a regulated and controlled

**Fig. 8.7** Photo of a drip irrigation tubing layout in a building landscaping

manner using valves, pipes, tubing and emitters cohesively. This can save water as irrigation is done is regulated manner and prevents evaporation losses. Figure 8.7 shows photo of a landscaping plants in a building with drip irrigation provisions.

### *8.5.2 Rain Sensors to Control Irrigation*

The rain sensor irrigation system encourages the moderate and wise use of water by leveraging on natural rain water whenever and wherever possible. A rain sensor typically works for the water sprinkler irrigation system. The sprinkler rain sensor operates through a gauge installed to the fence in proximity to the lawn or garden incorporated with the sprinkler system. There is a disc inside the gauge, it takes in water and expands as the rain continuously falls. These send a signal to the sprinkler system regulator, which stops the electronic signal that turns on the sprinklers until the disc contracts to their standard size. However, with this, the sprinkler regulator knows it's time to start the spraying and it turns on the sprinkler system automatically once again.

### *8.5.3 Xeriscaping*

Xeriscaping is a technique that emphasizes the selection of plants for water conservation. Drought-tolerant plants are an essential part of water efficient landscapes.

They are adapted to water scarce environments and therefore require minimal supplemental irrigation. They also require less maintenance than their water-needy counterparts. The specific plants used in xeriscaping depend upon the climate.

## 8.6 Water Reduction in Cooling Towers

Cooling towers are supplementary cooling systems used in water cooled chiller plants as described earlier in Sect. 5.1.1. Cooling towers rely on evaporative cooling to reduce the water temperature in order to reject heat in the condenser loop when producing chilled water. Although cooling towers are efficient heat rejection devices, they can consume a significant amount of water in buildings.

Cooling towers consume water in the following ways:

(a) Evaporation of water: this is a necessary thing for the system operation and the water savings can only be achieved in this area by optimising the system operations and reducing the cooling load.
(b) Bleed: Due to the evaporation of water, the cooling tower concentrates and accumulates both dissolved and undissolved or suspended solids that can lead to fouling of the system. This can be controlled by bleeding a portion of the circulating water from the system and replacing it with relatively clean make-up water.
(c) Drift: it is the small water droplets that leave the tower entrained in the tower discharge air. It is avoided by installing drift eliminators in the cooling tower. Controlling fan speeds and preventing ambient wind speeds from impacting the tower are ways of further reducing potential drift losses.
(d) Windage and splash out: Splash out refers to water leaving the tower via the air intakes and other openings in the tower casing. It can be reduced by installing anti splash louvers on the tower air intakes.
(e) Overflow and Leaks: Overflow is an uncontrolled water loss caused by water flowing back into the cold water basin and can be caused by poor pipe work, design and installation. Leaks result in water and chemical wastage and disturb the balance of water treatment systems by diluting the system with more make-up water than expected. Leaks are minimised by periodically reviewing the cooling tower and associated system for leaks and checks through establishment of a water balance as shown in Fig. 8.8.

### *8.6.1 Improving Cycles of Concentration*

The term cycles of concentration or concentration ratio refers to the ratio of impurities or the total dissolved solids (TDS) in the circulating water to the TDS in the make-up water. The selection of an appropriate level of cycles of concentration

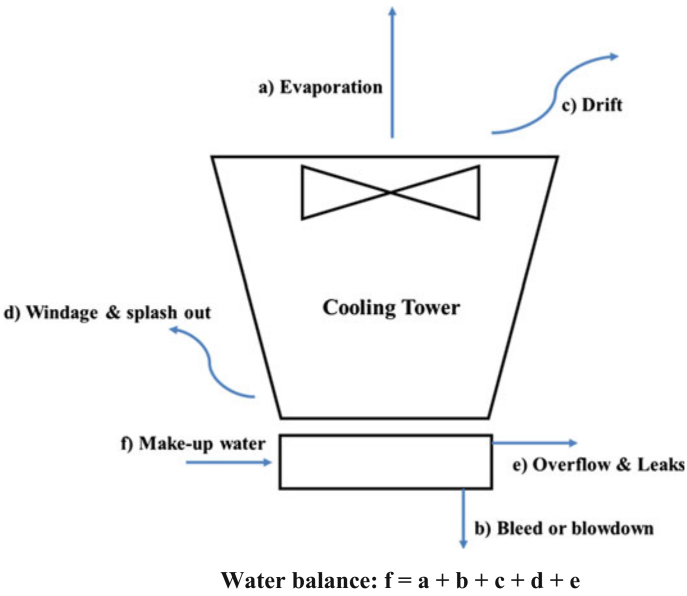


**Fig. 8.8** Water balance in a cooling tower (adapted from AIRAH 2009)

is a complex process and operators and water treatment service providers need to adopt a holistic approach to these considerations. The upper limit to the number of cycles of concentration that can be achieved is primarily determined by the purity of the make-up water. By increasing the cycles, this reduces the bleed, thereby reducing the amount of make-up water required by the system. Water treatment options can be used to assist in efforts to increase allowable cycles of concentration within the system. The make-up water can be pre-treated or filtered to improve its quality and hence allowing an increase in concentration ratio, so reducing bleed. Table 8.1 shows the potential reduction in water by increasing the cycles of concentration.

## 8.7 Reducing Construction Waste

The construction industry is one of the major waste producers worldwide and in the United Kingdom (UK) alone, the construction industry is responsible for some 120 million tonnes of construction, demolition and excavation waste every year, which is around one third of all waste arising in the UK (WRAP 2016). Figure 8.9 shows a photo of typical construction waste found on building construction sites.

**Table 8.1** Potential water savings that can be achieved by increasing the cycles of concentration in a cooling tower (AIRAH 2009)

Percentage of make-up water saved

| Old cycles of concentration number C1 | New cycles of concentration number C2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10 |
| 1.5 | 33 % | 44 % | 50 % | 53 % | 56 % | 58 % | 60 % | 61 % | 62 % | 63 % | 64 % |
| 2.0 | | 17 % | 25 % | 30 % | 33 % | 38 % | 40 % | 42 % | 43 % | 44 | 45 % |
| 2.5 | | | 10 % | 16 % | 20 % | 25 % | 28 % | 30 % | 31 % | 33 % | 34 % |
| 3.0 | | | | 7 % | 11 % | 17 % | 20 % | 22 % | 24 % | 25 % | 26 % |
| 3.5 | | | | | 5 % | 11 % | 14 % | 17 % | 18 % | 20 % | 21 % |
| 4.0 | | | | | | 6 % | 10 % | 13 % | 14 % | 16 % | 17 % |
| 5.0 | | | | | | | 4 % | 7 % | 9 % | 10 % | 11 % |
| 6.0 | | | | | | | | 3 % | 5 % | 6 % | 7 % |

**Fig. 8.9** Photo of construction waste on a building construction site (WRAP 2016)

### 8.7.1 Reuse and Recovery of Construction Materials

The reuse of material components and/or entire buildings has considerable potential to reduce the key environmental burdens (e.g. embodied energy, $CO_2$, waste etc.,) resulting from construction. Reuse of materials is possible with existing materials on site or use of new material for construction with high recycled content. The best opportunity to think about reuse is during the design stage when the designer can make a conscious effort to identify and specify the reuse of materials from the same or other buildings sites and also specify the recycled content in new materials being used on site. The other opportunity is for materials to be recovered effectively during the life of the building when maintenance and refurbishment is undertaken or when the building comes to the end of its life.

The following are some techniques to maximize reuse and recovery of construction material:

1. Reuse of excavated material as drainage base and mound features in landscape design.
2. Reuse or recycle of tarmac and asphalt for constructing pathways, construction storage space and hard standing for plants.
3. Reuse of top soil for green roofs and other landscaping use.
4. Reuse of existing landscape items if possible after repairing and refurbishment if required, rather than completely discarding them.
5. Use of recycle aggregates in concrete mix as fill.
6. Use pf cement substitutes such as PFA (pulverized fuel ash) and GBBS (ground granulated blast-furnace slag).
7. Recycling concrete elements as aggregates and use them as a thermal mass for heat energy storage.

8. Reuse of packaging material for other purposes or return it to supplier/manufacturer.
9. Reuse of timber for cladding, fencing and other landscaping uses.
10. Timber from demolition sites can be de-nailed and used as wood chips for composting, landscaping top mulch or taken off-site for energy generation plants that use wood-chips as fuel.
11. Reuse of bricks and blocks for masonry, internal partitions and fair faced cladding, while slate can be used for roofing and landscaping.
12. Salvaging good quality doors and other auxiliary fittings and fixtures that can be set aside for reuse or donated to charity.
13. Reuse of existing buildings on site for contractor's site establishment and use of temporary site establishment buildings that can be reused.

### 8.7.2 Optimising Material Usage During Construction and Deconstruction

Designers also need to consider how work sequences affect the generation of construction waste and work with the contractor and other specialist subcontractors to understand and minimise these without compromising the design concept and safety. This can be done by solutions that use less material and simplify the structural solutions as much as possible. For example, using concrete solutions like post tensioning instead of cast in situ reinforced concrete and reusable/modular shuttering for slabs cores. Designers should also review foundation solutions to ascertain if options such as rotary or displacement piles can be used and excavation can be avoided by optimizing building position.

Another good practice is to carry out three-dimensional co-ordination exercises to eliminate all dimensional conflicts that lead to extensive on site waste. Mechanical, Electrical and Plumbing (MEP) layout and distribution routes can be planned to reduce builders works by consolidating risers, ducts and pipe distribution network. Standardizing windows, doors and glazing areas as well as light fitting and lamps can also result in good material supply and packaging efficiencies. Material planners could also specify materials from local sources and procurement routes that reduce packaging.

The building can be designed for deconstruction flexibility at an early stage in the design process. This can be done by using mechanical fixtures and even structural elements that can be easily dismantled. Use of design foundations that can be easily retracted from ground for reused should be considered. To facilitate easier dismantling of bricks and blocks, lime mortar or other mortar could be used instead of concrete filling. Use of gluing and composite materials can be avoided to enhance deconstruction flexibility.

### 8.7.3 Pre-fabricated and Pre-finished Volumetric Construction (PPVC)

The benefits of off-site factory production in the construction industry are well documented and include the potential to considerably reduce waste especially when factory manufactured elements and components are used extensively. Technologies used for off-site manufacture and prefabrication range from modern timber and light gauge steel framing systems, tunnel form concrete casting through to modular and volumetric forms of construction (WRAP 2016).

Prefabricated Prefinished Volumetric Construction (PPVC) is a construction method whereby free-standing volumetric modules that are complete with finishes for walls, floors and ceilings, are pre-fabricated or manufactured in an off-site fabrication facility. They are then installed in a building under building works almost in a 'LEGO-style'. PPVC can significantly speed up construction and can potentially achieve a productivity improvement of up to 50 % in terms of man-power and time savings. It can also reduce dust and noise pollution while enhancing construction site safety and material usage. PPVC has become a new industry standard and is even mandated for new construction activities. E.g. in Singapore, PPVC is mandatory for selected non-landed residential Government Land Sale sites from 1 Nov 2014 onwards (BCA 2016). Figure 8.10 shows photo of a PPVC construction site in Singapore.

## 8.8 Waste Reduction, Reuse and Recycling

Apart from construction waste, there is a lot of waste generated by people who occupy, use and manage buildings. From stationary to plastic to food, there are a lot of things that people consume in buildings and that end up in the waste-bin. Most of us are familiar with the golden rule of waste management or the 3R rule of Reduce, Recycle and Reuse. While these rules are for people to follow, building owners and facility managers can make their application easy by making certain provisions in the building such as recycling bins, multiple special purpose waste chutes and options to use less paper and plastic in buildings.

### 8.8.1 Recycling Bins

By providing recycling bins, apart from the general waste bins, building owners and facility managers can encourage people in the building to recycle more. The selection of the bins, their numbers, placement and type of waste to be recycled (paper, plastic, cans, glass, etc.) can be customised to the building type and its occupant profile. In today's world, electronic waste (or e-waste for short) is also a

**Fig. 8.10** Site photo of a PPVC assembly in Singapore

major problem and most of the electronic goods and appliances can be recycled for metal extraction and possible reuse after repair and refurbishment. Provision of e-waste bins for end-of-use electronic appliances and consumables such as batteries can significantly enhance the recycling rates and even avoid hazardous consequences of such waste ending up in landfills and incineration plants.

Some recent advances in waste recycling bin design have in-built compactors to be able to accommodate more waste and increase the productivity of waste management operations. The compacting operation can even be powered by use of sustainable energy such as solar photovoltaic that can harness sunlight whenever available (see Fig. 8.11 for a photo of such recycling bin).

### 8.8.2 *Dual or Multiple Waste Chutes*

Waste chutes are common in communal housing buildings, where waste from several houses can be conveniently collected at a single location instead of door-to-door collection. However, this convenience is often abused by some occupants and all sort of waste gets thrown-in and sometimes in an inconsiderate manner. Building owners can consider incorporating dual or multiple waste chutes that are dedicated to certain waste disposal type. Provision of a separate waste chute for recyclable items makes it easier for occupants to dispose household waste for recycling. Some building owners provide separate waste chutes for organic and inorganic waste collection, so that organic food waste can be diverted to composting.


**Fig. 8.11** Photo of a solar-powered waste recycling bin installed outside a building in Singapore

### *8.8.3 Paper-Less Office*

Paper-less office is not a new concept, but it had been for most a dream that never comes true. It seems now increasingly more relevant in the era of handheld tablet devices, online or cloud storage, high storage capacity of removable storage devices (e.g. USB storage) and increase in data transfer speeds. Surprisingly, 50 % of the waste of businesses is composed of paper. Each year, the world produces more than 300 million tons of paper. According to the U.S. Environmental Protection Agency, printing and writing papers typically found in a school or office environment such as copier paper, computer printouts and notepads, comprise the largest category of paper product consumption. This is highly alarming in this digital era where electronic devices are so cheap and easily accessible.

Although a full paper-less office maybe a far reaching ideal, a near paper-less office is now possible with the available technologies and tools. The following tips can help in moving towards a nearly paper-less office:

1. Document Management system: hold reports and important documents online in a document management system that can help archive, store and share documents in a convenient way. There are now several document management tools and software available at an individual and enterprise level.
2. Adjust default settings for computers and printing.

   a. Set default paper-use in printers to double-sided printing and black-and-white prints.

b. Set creation of PDF (portable document format) instead of paper printer as default for printing and provide necessary electronic storage space for storing PDF documents.
c. Adjust computer settings to make on-screen reading easier and discourage printing of emails and other reference documents.

3. Reduce transactional paperwork through:
   (a) Paperless invoices, work orders and statements.
   (b) Electronic order processing and invoicing.
   (c) Online banking and money transfer (instead of written cheques).
   (d) Sharing electronic documents and using e-signature tools for contracts and other legal documents.
   (e) Internal online routing of documents for approval and endorsement.
   (f) Emailing documents instead of faxing.
4. Use digital technology for note-taking: using handheld devices such as tablet computers and smart phones for note-taking not only saves paper but also allows for easy retrieval and improves productivity.
5. Recycle and Reuse paper. Most copiers and printers now allow printing on reused paper through a special tray that can be selected for printing on such paper. It's also a good practice to allow re-use of wasted printed paper next to the copier or in a central location.

### *8.8.4 Eliminating Plastic Water Bottles*

Plastic bottles are still used in many office locations to provide water to guests and visitors coming for meetings and other purposes. This can be easily avoided by providing central water dispensers or hydration stations in pantries and other convenient locations (see Fig. 8.12). Some hotels are now practicing this and have managed to eliminate huge amount of plastic waste due to use of plastic bottles for drinking water. Same goes with plastic cups and Styrofoam cups, which are both environmental hazards when they end up in landfills. Providing people with reusable cups in offices can go a long way in reducing plastic waste.

### *8.8.5 Food Waste*

Food waste is also a big source of waste in buildings, especially ones where a food court or restaurants are part of the building e.g. shopping malls. Coffee grounds, trimmings from kitchen preparations, partially eaten meals, and leftovers from catering can all contribute to significant amount of organic food waste. Most of the

**Fig. 8.12** Photo of a hydration station that encourages reusable bottles for drinking water

time, the food waste end up in landfills due to a lower recovery of this type of waste in buildings.

As in any waste management program, the best option is to reduce the food wastage by encouraging people to think about the food portions and preparations that are catered to their needs. Food waste can also be avoided by ensuring that the left-over food in a catered buffet can be consumed by others or donated to charity while it's still in good conditions. If food has to be eventually wasted, there are useful ways of handling food waste instead of sending it to landfill or waste incineration. Composting and anaerobic digestion are examples of such useful food waste treatment options.

Composting is method in which food waste can be converted into useful fertilizers by breaking the organic matter down. There are a number of composting types: on-site composting, vermicomposting, aerated composting, and in-vessel composting. Vermicomposting is a solution that is becoming commercially viable. This option uses red worms that are placed in bins with organic matter in order to break it down into a high-value compost called castings. Building could help the composting chain by providing special compost recycle bins for food waste in the building (see Fig. 8.13). Food recycling bins however need to be regularly cleaned in order to ensure that the food waste does not decompose, which may lead to foul smells in the building.

Food waste can also be treated with anaerobic digesters, which consist of a biological process where microorganisms break down biodegradable material in the absence of oxygen. One of the end products of anaerobic digestion is biogas, which is combusted to generate electricity and heat, or can be processed into renewable


**Fig. 8.13** Photo of a recycle bin in an office that as provision to dispose food waste for composting

natural gas and transportation fuels. The main benefit of anaerobic digesters is that they can be self-contained and the food is not exposed to air, which avoids any foul smells during decomposing the food.

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